Biographical Sketch

Andrew R. Rundquist
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Education

Ph.D. in Physics (1998)
Washington State University, Pullman, WA and University of Michigan, Ann Arbor, MI
Thesis topic: "Phase-matched generation of coherent, ultrafast x-rays using high harmonics"
Advisors: Professors Henry Kapteyn and Margaret Murnane

M.Sc. in Physics (1995), Washington State University, Pullman, WA
Thesis topic: "Limits of ultrashort pulse generation in Titanium Sapphire"
Advisors: Professors Henry Kapteyn and Margaret Murnane

B.A. in Physics Summa Cum Laude (1993), College of St. Benedict/Saint John's University, Collegeville, MN

Professional Experience

Assistant Professor, Hamline University (2000-present)

Post-Doctorate Research Fellow, University of Texas, Austin, TX (1998-2000)

Educational Research Associate, University of Texas, Austin, TX (1999)

Research Assistant, University of Michigan, Ph.D. Thesis Research (1996-1998)

Consulting Research Engineer, ERIM International, Ann Arbor, MI (1997-1998)

Teaching Assistant, University of Michigan (1997)

Research Assistant, Washington State University, M.Sc. and Ph.D. Thesis Research (1993-1996)

Teaching Assistant, Washington State University (1994)

Research Assistant, Saint John's University (1991-1993)

Teaching Assistant, Saint John's University (1990-1993)

Honors and Affiliations

Member of the Optical Society of America (1998 – present)

Member of the American Association of Physics Teachers (AAPT) (1998 – present)

Best Poster Prize, Gordon Conference on Non-Linear Optics and Lasers (1997)

Student Poster Prize, Gordon Conference on Multiphoton Processes (1996)

GAANN Fellowship, Washington State University (1993-1995)

Presidential Scholarship, Saint John's University, Minnesota (1989-1993)

Reviewer/Referee for the following journals

Physical Review Letters, Optics Letters, Journal of the Optical Society of America A and B, Review of Scientific Instruments, Plasma Sources Science and Technology , and Optics Communications

Volunteer Teaching Experiences

Religious Education Teacher, St. Theresa's Catholic Church, Austin, TX (1999-present)
Advisor for the Middle Years Alternative Future Cities Competition, Ann Arbor, MI (1996-1998)
Educational mentor at the Opportunity Center at the Community Church of God, Ypsilanti, MI (1997-1998)

Personal

Citizenship: U.S.
Date of Birth: 1971; Marietta, GA

Professional Skills

Excellent oral and written communication abilities
Fluency in several computer languages including: LabVIEW, HTML, Matlab, Mathematica, MathCAD, C, Pascal, and BASIC
Experience building and interfacing equipment including lasers, computers, vacuum components, and spectrometers
Experience networking computers using serial, parallel, ethernet and Apple Talk protocols

Patents

Guided wave methods and apparatus for nonlinear frequency generation (US 6151155)

Other Interests

I enjoy singing choral music and playing the trombone, guitar, harmonica, and recorder. I was first trombone with the Washington State University Jazz Ensemble, which won the 1995, and 1996 Lionel Hampton Jazz Festival competition and was invited to the 1995 annual meeting of the International Association of Jazz Educators. I have performed with my trombone professionally with the Walter Thompson Orchestra and the Ariel Dance Company. I also play soccer, softball, golf, basketball, tennis, and ultimate frisbee.

Publications (journal papers denoted by *)

1.* Greg Taft, Andrew Rundquist, Margaret M. Murnane, Henry C. Kapteyn, Ken DeLong, Rick Trebino, Ivan Christov, "Ultrafast optical waveform measurements using Frequency Resolved Optical Gating," Optics Letters **20**, 743 (1995).

2. Andrew Rundquist, Greg Taft, Margaret M. Murnane, Henry C. Kapteyn, Ken DeLong, Rick Trebino, Ivan Christov, "Measurements of Ultrafast Optical Waveforms using FROG," Proceedings of the SPIE, Vol. **2377**, 201 (1995).

3. J. Peatross, J. Zhou, A. Rundquist, M.M. Murnane, H.C. Kapteyn, and I.P. Christov, "High-order Harmonic Generation with a 25 femtosecond laser pulse," Conference Proceedings for International Conference on Super-Intense Laser Atomic Physics, SILAP 95, 1996.

4. A. Rundquist, S. Backus, G. Taft, J. Peatross, M. Murnane, H. Kapteyn, "Temporal characterization of ultrashort high-power laser pulses," Proc. SPIE Vol. **2701**, 176 (SPIE, Bellingham, WA, 1996).

5.* I.P. Christov, J. Zhou, J. Peatross, A. Rundquist, M.M. Murnane, H.C. Kapteyn, "Non-Adiabatic Effects in High-Harmonic Generation with Ultrashort Pulses", Physical Review Letters **77**, 1743 (1996).

6.* Z. Chang, A. Rundquist, J. Zhou, M. Murnane, H. Kapteyn, X. Liu, B. Shan, J. Niu, M. Gong, X. Zhang, "Demonstration of a Sub-Picosecond X-Ray Streak Camera", Applied Physics Letters **69**, 133 (1996).

7. Z. Chang, A. Rundquist, J. Zhou, H.C. Kapteyn, M.M.Murnane, X. Liu, B.Shan, J. Liu, "Experimental Demonstration of a Sub-Picosecond X-Ray Streak Camera", Ultrafast Phenomena X, 152, Springer-Verlag (1996).

8. J. Zhou, A. Rundquist, Z. Chang, J. Peatross, I.P. Christov*, M.M. Murnane, and H.C. Kapteyn, "Enhanced High-Harmonic Generation with Ultrashort 25 fs Pulses", Ultrafast Phenomena X, 120, Springer-Verlag (1996).

9.* G. Taft, A Rundquist, M.M. Murnane, H.C. Kapteyn, K.W. DeLong, D.N. Fittinghoff, R. Trebino, "Measurement of Sub-Ten-Femtosecond Laser Pulses" **invited paper**, IEEE Journal of Selected Topics in Quantum Electronics **2**, 575 (1996).

10. Z. Chang, A. Rundquist, H. Wang, H. Kapteyn, M. Murnane, "X-ray streak camera with 0.54ps resolution", Proc. SPIE Vol. **2869**, 979 (1997).

11.* Z. Chang, A. Rundquist, H. Wang, H. Kapteyn, M. Murnane, "Generation of coherent x-rays at 2.7nm using high harmonic generation", Physical Review Letters **79**, 2967 (1997).

12.* A. Rundquist, C. Durfee, Z. Chang, G. Taft, E. Zeek, S. Backus, M. Murnane, H. Kapteyn, I. Christov, V. Stoev, "Ultrafast Laser and Amplifier Sources" **invited paper**, **65**, 161, Applied Physics B (1997).

13.* Z. Chang, A. Rundquist, H. Wang, I. Christov, M. Murnane, H. Kapteyn , "Generation of Coherent, Femtosecond, X-Ray Pulses in the "Water Window"", IEEE Journal of Selected Topics in Quantum Electronics, **4**, 266 (1998).

14. A. Rundquist , Z. Chang, H. Wang, E. Zeek, H.C. Kapteyn, M.M.Murnane, "Sort x-ray harmonics in the water window", Proc. OSA Conference on Generation and Applications of High Field and Short Wavelength Sources, Santa Fe, NM, p.45, Plenum Press, NY (1998).

15. C. Durfee, A. Rundquist , Z. Chang, J. Zhou, H.C. Kapteyn, M.M.Murnane, "Phase matching techniques for short wavelengths", Proc. OSA Conference on Generation and Applications of High Field and Short Wavelength Sources, Santa Fe, NM, p. 45, Plenum Press, NY (1998).

16. A. Rundquist, Z. Chang, H. Wang, I. Christov, M. Murnane, H. Kapteyn, "Attosecond Pulse Generation using High Harmonic Emission," AIP Proc. International Conference on Superstrong Fields in Plasmas, Varenna, Italy (1998).

17.* Z. Chang, A. Rundquist, H. Wang, H. Kapteyn and M. Murnane, "Temporal Phase Control of Soft-X-Ray Harmonic Emission", Physical Review A **58** , R30 (1998).

18.* J. Peatross, A. Rundquist, "Temporal Deconvolution of Short Laser Pulses", JOSA B **15**, 216 (1998).

19.* A. Rundquist, C. Durfee, S. Backus, C. Herne, Z. Chang, M. Murnane, H. Kapteyn, "Phase-Matched Generation of Coherent Soft-X-Rays," Science, **280**, 1412 (1998).

20. A. Rundquist, "Phase-matched generation of coherent, ultrashort x-rays using high harmonics," Thesis, Washington State University, (1998).

21. A. Rundquist, C.G. Durfee III, Z. Chang, C. Herne, S. Backus, M.M. Murnane, H. Kapteyn, "Phase-matched generation of coherent soft-x-rays," Optics and Photonics News, **9**, 54 (1998).

22.* M.K. Grimes, Y.-S. Lee, A. Rundquist, M.C. Downer, "Experimental identification of "vacuum heating" at femtosecond-laser-irradiated metal surfaces," Physical Review Letters **82**, 4010, (1999).

23.* C.G. Durfee, A.R. Rundquist, S. Backus, Z. Chang, C. Herne, H.C. Kapteyn , M.M. Murnane, "Guided-wave phase-matching of ultrashort-pulse light," Journal of Nonlinear Optical Physics **8** , 211, (1999).

24.* C.G. Durfee, A.R. Rundquist, S. Backus, C. Herne, M.M. Murnane, H.C. Kapteyn, "Phase matching of high-order harmonics in hollow waveguides," Physical Review Letters **83**, 2187, (1999).

25. M. K. Grimes, Y.-S. Lee, A.R. Rundquist and M. C. Downer, "Experimental identification of "vacuum heating" at femtosecond-laser-irradiated metal surfaces," High Field Science, Edited by T.Tajima, K.Mima, and H.Baldis, p. 63, Plenum Press, NY, (1999).

26. A. R. Rundquist, M. K. Grimes, Y.-S. Lee, and M. C. Downer, "Experimental identification of "vacuum heating" at femtosecond-laser-irradiated metal surfaces," Conference Proceeding for Lasers '98, (1999).

27.* N.E. Andreev, M.V. Chegotov, M.C. Downer, E.W. Gaul, N.H. Matlis, A.A. Pogosova, A.R. Rundquist, "Propagation of intense laser pulses through inhomogeneous ionizing gas profiles," IEEE Journal of Quantum Electronics , **28** 1090 (2000).

28.* S.P. Le Blanc, E.W. Gaul, N.H. Matlis, A. Rundquist, and M.C. Downer, "Single shot measurement of temporal phase shifts by frequency domain holography," Optics Letters, **25** 764 (2000).

29.* E.W. Gaul, S.P. LeBlanc, A.R. Rundquist, R. Zgadzaj, H. Langhoff, and M.C. Downer, "Production and characterization of a fully ionized He plasma channel," Applied Physics Letters, **77** 4112 (2000).

30. A.R. Rundquist, S.P. LeBlanc, E.W. Gaul, S. Cheshkov, F.B. Grigsby, T.T. Tajima, and M.C. Downer, "Optimization of laser wakefield acceleration," Advanced Accelerator Concepts 2000, AIP Proceedings , **569**, 177 (2001).

31. E.W. Gaul, S.P. LeBlanc, A.R. Rundquist, R. Zgadzaj, N.H. Matlis, H. Langhoff, M.C. Downer, "Production and characterization of a fully ionized He plasma channel," Advanced Accelerator Concepts 2000, AIP Proceedings , **569**, 105 (2001).

32. E.W. Gaul, N.E. Andreev, M.V. Chegotov, M.C. Downer, N.H. Matlis, A.A. Pogosova, A. R. Rundquist, "Intense laser pulse propagation through inhomogeneous ionizing gas profiles," Proceedings of the 1999 International Conference on Lasers (LASERS '99), p. 281 (2001).

33.* A.R. Rundquist, A. Efimov, D. Reitze, "Pulse shaping with the Gerchberg-Saxton algorithm," Journal of Optical Society of America B, **19** 2468 (2002).

News Articles

1. D. Kestenbaum, "Transmuting light into x-rays," Research news, Science, **280**, 1348, 05/29/1998.

2. P. Schewe, B. Stein, "The first practical, coherent soft x ray source," Physics News, **376**, 06/11/98.

3. O. Port, "... and sharper images for x-ray pictures", Developments to watch department, Business Week, 06/15/98.

4. "Engineers unveil tabletop x-ray laser," Ed. A. Hand, Technology world briefs, Photonics Spectra, **32**, 60, July (1998).

5. A. Hohl, "Harmonic conversion: phase-matching efficiently produces soft-x-rays," World news, Laser Focus World, **34**, 46, August (1998).

6. P. Schewe, "A coherent soft x-ray source," Physics update, Physics Today, **51**, 9, August (1998).

Presentations

1. Contributed talk, "Sub-10 fs waveform measurements using frequency resolved optical gating." SPIE Annual Symposium OE'LASE, San Jose, CA, (1995).

2. Contributed talk, "Temporal Characterization of ultrashort high-power laser pulses." SPIE Annual Symposium OE'LASE 96, San Jose, CA, January (1996).

3. Contributed poster, "Ultrashort Pulse Shape Characterization for Optimization of Harmonic Generation.", Gordon Conference on Multiphoton Processes, New London, NH 1996.

4. **Invited talk,** "Femtosecond X-ray generation using high-harmonic generation of 25 fs pulses." International Laser Science Conference, ILS XI, Rochester, NY (1996).

5. Contributed poster, "Enhance Harmonic Generation Using Birefringent Pulse Shaping OSA Conference on Generation and Applications of High Field and Short Wavelength Sources, Santa Fe, NM (1997).

6. Contributed poster, "Methods of Ultrashort Pulse Characterization.", Gordon Conference on Non-Linear Optics and Lasers, New London, NH 1997.

7. **Invited talk,** "Generation and Detection of High Harmonic Generation." International Workshop on Measurements of the Ultrafast Dynamics of Complex Systems with Short Wavelenght Radiation, Montreal, QC, Canada (1997).

8. Contributed talk, "Pulse Characterization using Temporal Information Via Intensity (TIVI).", OSA Annual Meeting, Long Beach (1997).

9. Contributed talk, "Extreme Non-Linear Optics: Femtosecond to Attosecond Coherent X-Rays.", OSA Annual Meeting, Long Beach (1997).

10. Contributed talk, “Controlling the intrinsic atomic phase in high harmonic generation.”, CLEO/IQEC, San Francisco (1998).

11. Contributed poster, "Phase-matched generation of coherent ultrafast x-rays using high harmonics.”, Gordon Conference on Multiphoton Processes, Tilton, NH 1998.

12. Contributed talk, "Phase-matched generation of coherent, ultrashort soft-x-rays using high harmonics.”, OSA Annual Meeting, Baltimore (1998).

13. Contributed talk, "Vacuum heating for the first time.”, APS Centennial Meeting, Atlanta (1999).

14. **Invited talk,** “Accelerating charged particles using ultrashort pulses.” Texas Section of APS Annual Meeting, Austin (1999).

15. Contributed poster, A. Rundquist, A. Efimov, D.H. Reitze, "Real-time phase mask synthesis for generation of arbitrarily complex waveforms using Gerchberg-Saxton algorithm," Conference on Lasers and Electro-Optics, May 10, 2001.

16. Contributed talk, A. Rundquist, “Hamline/3M Project: Liason for Curricular Change,” American Physical Society annual March meeting, Indianapolis, IN 03/18/02.

17. Invited talk, A. Rundquist, “Optimization of Ultrafast Phenomena,” New Laser Scientist Conference, Orlando, FL 09/29/02.

Andy Rundquist

Teaching Philosophy

My teaching philosophy has been born from both my own teaching experiences and the examples of the many professors I have had. My experience at a small liberal arts undergraduate institution provided me with excellent models for the type of well-rounded teaching that must occur for the varied students involved. The best teaching professors I have known have been able to deal with tough concepts by anticipating questions and puzzled looks. As a student, this method helped me to excel and I always try to emulate it.

A teacher has to constantly recognize the future needs of the student while helping with the present problems. Many fundamental principles in physics are applied and reapplied indefinitely and the teacher must make sure that they are taught not solely to solve the present problem, but to give the student the tools s/he will need for the future. Math is a powerful and much needed tool for physicists, but the concepts are the heart of the science. I believe that discussions both with the professor and other students are the best way to fully comprehend a concept. The equations which concisely state the principles can be vague and dry and it is the teacher's responsibility to breath life into them by providing the discourse that is needed. For me, this is accomplished by having an open environment where questions and discussions are common, by making my help available on all assignments, and by promoting collaboration among the students.

One word sums up what I consider to be the most important thing both in and out of the classroom: enthusiasm. A student who sees that the teacher is excited about both the question and the answer is one who will learn more. Having the title of professor already puts the teacher in a position of authority. Not knowing *all* the answers makes him approachable and having enthusiasm generates a fast rapport with the students.

The connection between the classroom and the lab is crucial for students' development. This relationship must be enhanced to include an understanding of the infinite real-world applications of physics. Classroom demonstrations and discussions of the uses of the newest concept and equations are vital to a rich learning environment. By pointing out how new advances in everyday technology have come about through physics research, the teacher brings a thirst for knowledge and an atmosphere of excitement to the classroom.

Studying physics is studying problem-solving. Recognizing this helps me to see the similarities between "majors" and "non-majors". With enthusiasm along with insight into the most important lessons physics has to teach, my students will have a fresh view of a field known for being hard and dry. I hope they will appreciate a healthy balance of lectures and laboratory experiences and will come to value an interactive physics classroom.

Andy Rundquist

Research Contributions

My research has been in the area of ultrashort-pulse lasers and the interaction of intense light pulses with matter. This work involves a mix of small-scale work which can be the basis for undergraduate-oriented student research as well as somewhat more complex and challenging work; both aspects remain at the forefront of optical science. Developments in laser technology, many of which occurred in the research group where I did my Ph.D. work, have made it possible to easily generate light pulses of 10 femtoseconds duration – only a few optical cycles – and with peak power greater than the total electrical capacity of the U.S. In my Ph.D. work, I helped to understand the mechanisms which let us make these short pulses by inventing and implementing techniques to measure the exact shape and duration of the light pulses.

With such well characterized pulses, I was able to carefully study the interaction of matter with very intense light which has an electric field magnitude far stronger than the field binding an electron to an atom. These extreme fields lead to extreme non-linear optical phenomena. I have concentrated on two important limits of these phenomena: the highest energy harmonic photons which can be produced and phase matching of high harmonic generation. For the former, I have shown that it is possible to generate coherent light corresponding to the 300^{th} harmonic of the fundamental laser frequency (at 0.5 keV photon energy). These extreme harmonics, however, have poor conversion efficiencies ($<10^{-8}$) which motivated my work on phase matching the high harmonic generation process. Using hollow-core capillary fibers, I have demonstrated a 1000-fold increase in conversion efficiencies from 25nm soft-x-ray radiation. This work is a great breakthrough for fields as diverse as lithography, ultrafast chemistry and biology, and x-ray spectroscopy since appreciable photon numbers can now be generated with a simple table-top laser.

In my most recent role as a post-doctoral senior researcher at the University of Texas, I have supervised and participated in numerous experiments along with performing several administrative and organizational tasks. One of my current projects is to further develop and refine take-home electrical circuit kits ("Cir-Kits") for introductory electricity and magnetism courses. In collaboration with Prof. Mike Downer, I have utilized pre- and post-tests along with student interviews to examine the effectiveness of these tools in enhancing students' understanding of fundamental electrical and magnetic concepts. I am also currently working to optimize the interaction of ultrashort high intensity light with plasmas using ultrafast pulse shaping and genetic algorithms.

With experience in a broad range of ultrafast optics along with a state-of-the-art 12 femtosecond laser already available to me, I feel I can provide students with creative opportunities to enhance their physics understanding. Working in a field currently experiencing exponential growth, my students will be able to perform leading-edge research while learning valuable tools for every aspect of their education.

References

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